

## > DO BROADBAND AND INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs) HAVE A POSITIVE IMPACT ON SCHOOL PERFORMANCE? EVIDENCE FOR CHILE

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> This paper was carried out with the assistance of a grant given to IEP by the International Development Research Centre and the Canadian International Development Agency (CIDA), Ottawa, Canada

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Do broadband and ICTs have a positive impact on school performance? Evidence for Chile

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**Lima:** Regional Dialogue on the information society, 2013.

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## ABSTRACT

This article studies the impact of connectivity to broadband and the use of Information and Communication Technologies for pedagogical purposes on the quality of education of students in the basic-education cycle in Subsidized Educational Institutions (SEIs) in Chile. To conduct this study the impact is estimated for two initiatives of the Ministry of Education (MINEDUC for its acronym in Spanish), Funds for Broadband (FBA for its acronym in Spanish) (2006-2010) and ICT in the Classroom (2007-2011), on the performance of students in national standardized tests for language and mathematics established by the Education Quality Measurement System (SIMCE for its acronym in Spanish), available since 1998. The unit of observation is the student and the isolated, joint and focused effect is analyzed of the programs mentioned upon cohorts that provide evaluations at two moments of time. The study sample excludes SEIs pertaining to the high socio-economic group and, in the case of ICT in the Classroom, only municipal schools are used. The results show that the programs do not have significant effects upon the performance, either isolated or jointly, but it was possible to identify the positive effects of ICT in the Classroom for specific groups in Language, but not for Mathematics.

# 1. INTRODUCTION

The Regional Dialogue on the Information Society Network (REDIS)<sup>1</sup> is conducting the research Project “Adoption of broadband and poverty: evidence and new research directions for Latin America”. The objective of the project is to enrich the debate on this matter and one of its components consists of carrying out five evaluation studies of the impact on three goals of interest: economic growth, generation of employment and educational achievements.

Chile is one of the countries included in this project for evaluating the impact of adoption of broadband programs on educational achievements, with regard to the subsidies for connectivity implemented by the Center for Education and Technology (ENLACES for its acronym in Spanish)<sup>2</sup> from 2006 to 2010. Likewise, in ENLACES various initiatives are carried out (programs and projects) that promote the use of ICTs in pedagogical activities within the classroom. All these initiatives are contained within the Plan “Technologies for a Quality Education (TEC for its acronym in Spanish)”, that in short is called Plan TEC. With the support of professionals from ENLACES two specific programs to study were selected, a connectivity program and one for the use of ICTs,<sup>3</sup> for which the monitoring data of the implementation process is available:

- ❖ Connectivity: Funds for Broadband (2006-2010)
- ❖ Use of ICTs: ICT in the Classroom (2007-2011)

On the other hand, the Ministry of Education of Chile (MINEDUC), has implemented the Education Quality Measurement System (SIMCE),<sup>4</sup> with information from 1998 with which the performance of the students is measured in three sub-sectors: Language and Communication (hereinafter “language”); Mathematics Education (hereinafter “mathematics”), and Understanding of Natural, Social and Cultural Environment (hereinafter

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<sup>1</sup> <http://www.dirsi.net/>

<sup>2</sup> ENLACES began as a pilot project in 1992, in 1995 it was expanded to a national program and in 2005 it became a Center for Education and Technology: [www.redenlaces.cl](http://www.redenlaces.cl)

<sup>3</sup> Originally a third program, the Mobile Computer Laboratory, was being considered however, given that for this program there is only information for 2009 and it was implemented only for 3rd grade, it was excluded from the analysis. This is because it was not possible to construct a cohort, but rather only a cross section database with the SIMCE 4<sup>th</sup> grade test in the year 2010.

<sup>4</sup> <http://www.simce.cl/>



“sciences”). The results in language and mathematics were used as impact indicators in the evaluation of these programs.<sup>5</sup>

The general objective of the study is to estimate the impact of the connectivity to broadband internet and of the encouragement of use of ICT for pedagogical purposes on the quality of the education of the basic cycle students in Educational Institutions (EIs) in Chile.

The specific objectives are:

- ❖ Estimate the impact on SIMCE test results (language and mathematics) of the students in the basic-education cycle, of each one of the two programs independently: Funds for Broadband and ICT in the Classroom, corrected by identification variables associated with the EI and the home.
- ❖ Estimate the impact of the interaction of the two programs on the SIMCE (language and mathematics) test results of basic-education cycle students.

The rest of the article is organized as follows. In section 2 a review of the state of the art in the topic is made. Section 3 describes the details of the programs under study, while section 4 establishes the methodological foundations of the impact analysis. Section 5 contains the econometric model being applied and section 6 contains the analysis and the main results. In the last section the conclusions are presented.

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<sup>5</sup> Originally the results of the SIMCE Sciences were proposed to be included, however they were excluded from the analysis because they are not comparable between the two grades selected: in 4<sup>th</sup> grade the test refers to understanding of the natural and social environment, while in 8<sup>th</sup> grade the two subjects are separated into understanding of the natural environment and understanding of the social environment.

## 2. BIBLIOGRAPHIC REVIEW

In this section the literature associated with the impact of education programs based on the use of ICTs and connectivity will be reviewed. Angrist and Lavy (2002) distinguish between two categories for the educational use of computers: Computer Skills Training (CST), where the students are taught how to use a computer, and Computer-Aided Instruction (CAI), which focuses on the use of computer tools to increase the effectiveness of the teaching-learning process.<sup>6</sup> While the first has not been questioned, the CAI role has been controversial since results in different directions have been obtained in the literature.<sup>7</sup> In order to clarify the explanation, an additional distinction with regard to the CAI concept will be adopted. On one hand, the role of the use of computers to increase school performance will be analyzed, while on the other the role of connectivity to pursue the same objective will be discussed.

Machin et al. (2006) found a positive impact of the investment in ICTs upon the educational achievements in English and science in primary schools, but no effect in mathematics. Spiezia (2010) directly studied the impact of the use of computers upon educational achievements. He analyzed a database of 33 countries (26 OECD and 7 outside) with information from the OECD Program for International Student Assessment (PISA). After correcting for potential spurious correlation and endogeneity problems, the author found that the use of computers at home has a significant effect upon the average scores in sciences, but also found that in the large majority of countries considered, the use of computers in school does not have significant effects. Along the same lines, Roman y Murillo (2012) controlling by socioeconomic and cultural variables, found a significant and positive effect for having a computer at home, insofar as the student does *not* use it to do homework, and in addition report a significant and positive effect for attending a school with a minimum quantity of computers and with a frequent use of them. The authors also

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<sup>6</sup> Additionally, some authors have studied the impact of public policies to reduce the digital gap. For example, Goolsbee and Guryan (2002) evaluated the effect called "E-Rate subsidy" upon the investments in internet in public schools in California from 1998 to 2000. They estimated that approximately 66% more classrooms had access to internet than what would have occurred in the absence of the subsidy, but they also report that there has been no significant impact upon the performance of the students.

<sup>7</sup> For example, Cristia et al. (2010) studied whether an increase in the access to ICTs leads to an improvement in the number of years of education completed. The analysis was done with a database with information for 350 schools in Peru and significant effects were not found. Despite this, the authors suggest the CST effect is important enough in the job market to justify an intervention of public policy: "[S]ome basic level of ICT access in all schools should be promoted and that devoting limited resources to teaching ICT skills may be optimal."

show the presence of a double exclusion effect for rural students in developing countries (poverty + rurality). However, it should be mentioned that the majority of the studies have not found significant effects and some have even detected significantly negative effects on school performance (Goolsbee y Guryan, 2002; Rouse y Krueger, 2004; Leuven et al., 2007; Sprietsma, 2012, among others).

Claro (2010) carried out a state of the art review of the impact of ICTs on learning. She distinguished between:

- ❖ Type of use of ICTs and its impact upon learning: associated with the characteristics of the ICT application.
- ❖ Conditions of use of ICTs and its impact upon learning: associated with the characteristics of the environment (school) where the application is carried out.
- ❖ Who is using the ICTs and its impact upon learning: associated with the characteristics of the students.

She found that a positive impact on learning usually is associated to a specific use of technologies, which facilitates the understanding of specific concepts. With regard to the conditions of use, the role of the teachers and of the director of the school is key to encourage the learning processes through ICTs. Finally, with regard to personal characteristics, the question is "How well prepared are the students to improve their capacity to understand through the use of ICTs?". The cultural capacity appears to be fundamental here. This line of discussion has moved towards a new concept: The second digital gap. This is a concept that is not related to access, but rather to the difference in the capacities to use the ICTs as an effective learning tool. Along the same lines, Carrillo et al. (2010) reports a positive effect for an ICT program in Guayaquil, Ecuador, in the mathematics test scores (but no significant effects are observed in language). They understand the impact to be the result of the combination of hardware, software, and teacher training. Rodríguez et al. (2012) also explain that the basic units are the educational programs supported by ICTs which should be carefully designed and evaluated.

A different branch in literature is that related to the impact of access (broadband, internet or SMS) upon learning. Underwood et al. (2005) and Davidson and Santorelli (2010) studied the impact of the broadband adoption on education in UK and USA, respectively. In the first article, the authors present some practical experiences of adoption concluding: "broadband is changing the way pupils learn and construct their work, changing the ways teachers organise lessons and co-operate with

colleagues, and changing the way schools administer their courses." In the second, the authors conclude that:

*[I]n the long term, wireless broadband and advanced mobile devices will likely serve as primary vehicles for the delivery of educational content. This will expand access to «anywhere, anytime» learning. Moreover, these and other approaches will shift the education paradigm toward more personalized learning.*

Despite these optimist visions based on particular experiences or conceptual approximations, there is very little evidence in the world regarding statistically significant impacts upon learning (see Scheuermann and Pedro, 2009 and Sprietsma, 2012), furthermore there are some cases in which significant negative effects have been reported (see for example, Belo et al., 2010).<sup>8</sup>

In a recent article, however, Aker et al. (2012) studies the impact of access to basic mobile telephony technology upon the educational achievements of adults in a field experiment in Niger. They report a significant increase in the mathematics and writing test scores in relation to the control group. Additionally, it shows that the positive and significant effect continues to be present several months after classes have finished. The authors suggest that the mobile telephone can be a simple and low cost way to improve the educational results in adults.

In the case of Chile it is important to mention that ENLACES has contracted the realization of various studies of process evaluation of its programs, but not for impact. The only study that is reported in literature is that of Contreras et al. (2007), cited by Claro (2010), who found a positive correlation between the use of broadband and the language and mathematics scores in SIMCE 2005 in 4<sup>th</sup> grade, it being significant for students of low and middle socio-economic levels but not for high.

In short, the evaluations of the impact of the use of ICTs on learning as well as the studies of the impact of connectivity on learning have led to troubling results, given that in the majority of them it is not possible to identify the impacts while in others negative and significant impacts have been detected. With this evidence it becomes of particular importance to measure the impact of programs for the use of ICTs in the classroom and for connectivity in Chile.

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<sup>8</sup> In fact, the impact of access to broadband has been questioned beyond its potential effect on education. Kenny (2011) argues that there is no evidence of a large positive economic impact, in such a way that the grounds for subsidizing the penetration of broadband are weak.

### 3. PROGRAMS UNDER EVALUATION AND INFORMATION

The objective of this section is to provide a description of the programs that will be evaluated. In particular, details will be given of the benefit, target population, selection criteria of beneficiaries, period of execution and expected chain of results.

The framework in which these programs were carried out is also of utmost importance. By the year 2007, the ENLACES program had already become the main political policy of Chile to reduce the digital gap. The services that are delivered include: computer equipment, connectivity, educational resources, technical assistance and teacher training. The mechanism through which these services are provided is through programs, two of which constitute our object of study. In accordance with the Scholar Digital Development Index (IDDE for its acronym in Spanish), and in particular the National Census of Computer Education for the year 2009,<sup>9</sup> in the country there were 91814 educational institutions in the subsidized system (SEIs), which constitute the population to which the different programs were directed.

In the case of the Funds for Broadband program, as of 2007 it was estimated that around 67% of the population of students (SEIs plus private) had access to broadband. The plan attempted to gradually connect all the schools in the country, which led to setting a goal of connecting 3500 institutions by 2010 with a start-up cost of US\$220000 and an estimated annual cost of US\$1.7 million. In practice, in 2010 the plan generated subsidies for 4309 SEIs with an annual cost of around US\$3.5 million.

On the other hand, the ICT in the Classroom program in 2007 established a specific expansion timetable, which attempted to have by 2010 a total of 16000 classrooms implemented. The specific timetable is shown in Table 1. The subsidy consists of an "ICT in the Classroom" Kit which includes a notebook, a multimedia projector, ceiling support for multimedia projector, audio equipment and a retractable screen. In addition a monetary contribution was contemplated of around US\$ 400/classroom for the adaptation of spaces and free technology consultancy for the SEIs that includes educational software and training for teachers.

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<sup>9</sup> See <http://idde.enlaces.cl/index.php>, visited April 12, 2013.

**Table 1. ICT in the Classroom Coverage Plan**

Years	2007	2008	2009	2010	Total
First cycle of basic education classrooms	3200	3500	1200	0	7900
Second cycle of basic education classrooms	0	3500	3500	1200	8200
Total	3200	7000	4700	1200	16100

The details as to how these programs operate are given in the following subsections.

### 3.1 Funds for broadband (2006-2010)

The objective of this program is to grant a subsidy to co-finance the contracting of Broadband Internet in the Subsidized Educational Institutions (SEIs), as support for educational activities. The SEIs are municipal or private schools that receive a subsidy from the State of Chile for each registered student, governed by the Subsidy Law (DFL No. 2 1998).<sup>10</sup>

The program was initially carried out during the 2006-2008 period, incorporating rural SEIs in 2008. Then, as part of the "Technologies Plan for a Quality Education-Bicentennial Connections (Plan TEC)", it was extended for two more years (2009-2010), concluding in the year 2011. As of 2012 these subsidies are being implemented together with the Subsecretary of Telecommunications (SUBTEL for its acronym in Spanish), under the Connectivity Program for Education, whose challenge is to have all the subsidized institutions in the country connected to the Internet by 2014.

At the beginning of the program, the amount of the subsidy was calculated based on the socio-economic level of the SEI in the last SIMCE test: 90% for A (Low) or B (Medium Low) and 70% for C (Medium high) or D (High). The maximum amount of the subsidy was \$20000 (US\$ 40) per month for urban SEIs and \$31000 (US\$ 62) per month for rural SEIs and/or SEIs of the extreme south of the country. In 2009 a copayment for the beneficiary institutions was implemented according to the classification of

<sup>10</sup> The institutions excluded from this target population are those private schools with 100% private financing.

[http://www.comunidadescolar.cl/marco\\_legal/Normativas/DFL%202%20Ley%20Subvenciones.pdf](http://www.comunidadescolar.cl/marco_legal/Normativas/DFL%202%20Ley%20Subvenciones.pdf)

vulnerability and size:<sup>11</sup> \$5000 (US\$10) monthly co-payment for the vulnerable SEI and \$10000 (US\$20) for the non-vulnerable ones. The maximum subsidy amount was set at: \$40000 (US\$80) for the large vulnerable ones or rural vulnerable ones; \$33000 (US\$66) for the small vulnerable ones; \$35000 (US\$ 70) for the non-vulnerable and large or non-vulnerable and rural ones; \$28000 (US\$56) for the non-vulnerable small ones.

With regards to the participation conditions, all the SEIs were invited to participate, but to apply they had to comply with the following requirements: be incorporated in the ENLACES Network; have contracted and have active Broadband Internet services with any provider; not have received Funds for Broadband benefits prior to the year 2004, or connectivity of broadband benefits of the Fund of Development of Telecommunications (FDT) of the Ministry of Transport and Telecommunications; not have administrative sanctions and be willing to comply with the time periods and requirements of the terms. The SEI that receives benefits for a specific year can request the continuation of the benefit for following years, as long as they have the rendition of prior funds as "Approved". In 2009 the requirement was introduced that the SEI confirm their participation in the Plan "Technologies for a Quality Education – Closing Digital Gap" in the year 2008. In 2009 the prioritization of the applicant SEI that serves the most vulnerable population was also incorporated as a selection criteria.

Illustration 1 shows the chain of results of the Program, from which three possible levels of impact evaluation are derived:

- ❖ Impact of the program on the level of sustainability of the use of Broadband Internet.
- ❖ Impact of the program on the number of hours per week assigned by the SEI for the use of internet for pedagogical purposes.
- ❖ Impact of the program on the academic performance of the students.

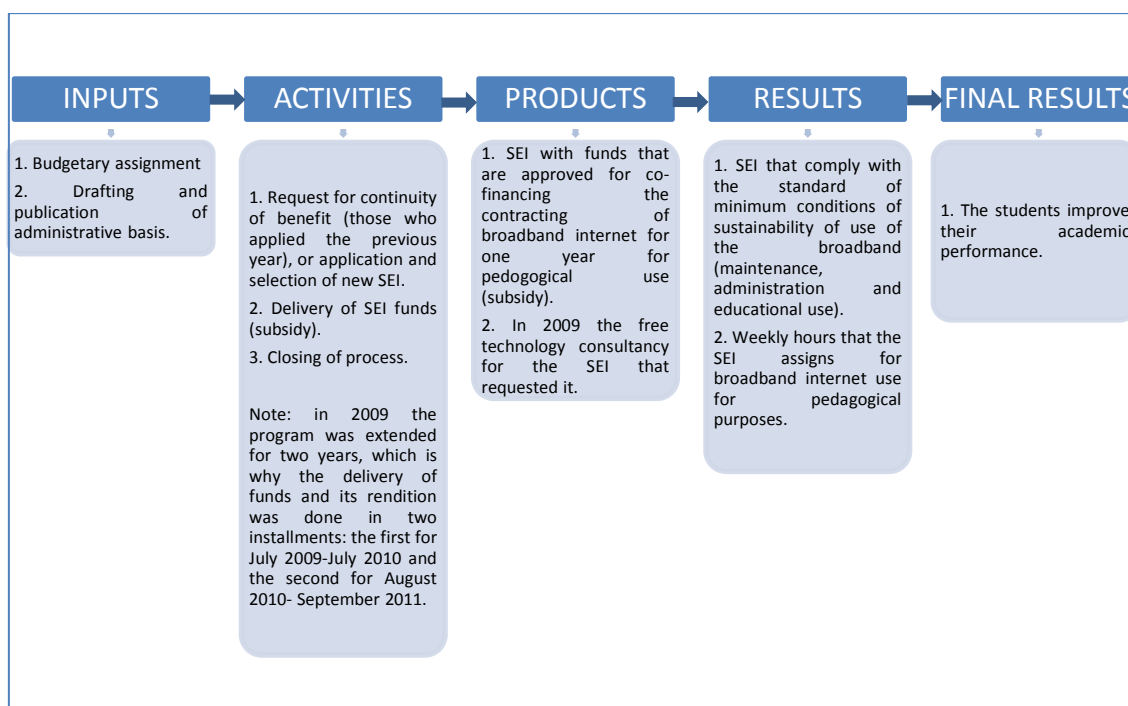
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<sup>11</sup> Those institutions that in their last SIMCE test were classified in the A (Low) or B (Medium Low) socio-economic group were classified as vulnerable. Those institutions that in their last SIMCE test were classified in the C (Medium High) or D (High) socioeconomic group were classified as not vulnerable.

Those institutions that, according to 2010 standard, are entitled to one Computer lab or none were classified as small. Those institutions that, according to 2010 standard are entitled to 2 or more Computer Labs were classified as large. The size classification is only relevant for urban EI.

In this article the impact evaluation concentrates on the third level, that is, the academic performance of the students in the SIMCE national tests. The reason for is the lack of information for evaluating the intermediate impacts, which would require information on intensity of use.

### Illustration 1. Chain of results of the Funds for Broadband Program in Subsidized Educational Institutions – SEIs – (2006-2010).



## 3.2 ICT in the Classroom (2007-2011)

The ICT in the Classroom program is one of the strategic projects of the MINEDUC whose objective is to contribute to the improvement of the quality of education and development of a quality, equity and pertinence digital culture. Specifically the ICT in the Classroom program has two objectives: (i) assure a base of technological and pedagogical digital resources inside the classroom for the teaching and learning process (Language, Mathematics and Understanding of the Natural Environment); (ii) support the teachers in the four areas of the Framework for Good Teaching.<sup>12</sup> The first year of the program is focused on basic cycle (1<sup>st</sup> to 4<sup>th</sup> grade) of the municipal EI and then it was expanded to all the SEIs that form part of the Preferential School Subsidy (SEP), for the first and second basic cycle (1<sup>st</sup> to 8<sup>th</sup> grade) that receives technical assistance

<sup>12</sup> The four areas refer to the stages of the entire cycle of the educational process: Planning, creation of environments conducive to learning, teaching and finally, evaluation and reflection.



from MINEDUC. The program was executed from 2007 to 2010, and extended to 2011.

The benefit consisted in the delivery of a "ICT in the Classroom Kit" and a set of digital resources (CD's) to support the classes, funds for co-financing the adaptation of the classrooms (US\$400/classroom), free technical consultancy by the Technical Assistance Network (RATE for its acronym in Spanish) and training of the teachers in the four areas of the Framework for Good Teaching. The "ICT in the Classroom Kit" consisted of a portable computer or notebook, a multimedia projector, a ceiling support for the multimedia projector, audio equipment and a retractable screen.

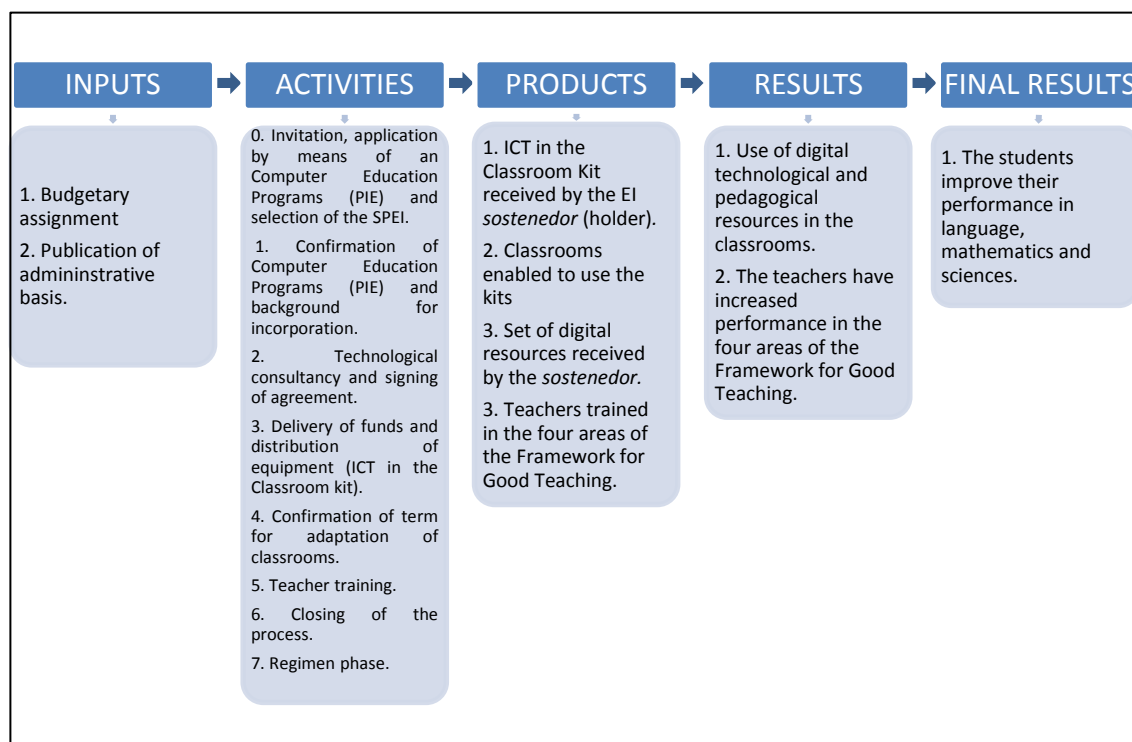
With respect to the participation in the program, initially the potential EI participants were proposed by the General Education Division, and then they were invited to apply by means of a Project for Computer Education (PIE for its acronym in Spanish). To apply, the EI had to comply with two requirements: have 1<sup>st</sup> to 8<sup>th</sup> grade classes in operation (1<sup>st</sup> to 4<sup>th</sup> grade in the first year) and have a set of physical conditions and necessary sustainability in order to make good use of the computer infrastructure. The EI selected has to comply with three types of minimum conditions: infrastructure, adaptation, and sustainability of the project. The process was carried out in seven stages, implementing a system for review and confirmation of delivery, installation and corresponding adaptation. In the regimen phase, the MINEDUC supervised the compliance and respect of the conditions assumed by the *sostenedor* (holder) with PIE and the program agreement.

Illustration 2 describes the chain of results of the program and based on these three possible levels of impact evaluation are derived:

- ❖ Impact of the program on the use (frequency and intensity) of technological and pedagogical digital resources in 1<sup>st</sup> to 8<sup>th</sup> grade basic cycle classrooms.
- ❖ Impact of the program on the performance of the teacher in the four areas of the Framework for Good Teaching.
- ❖ Impact of the program on the academic performance on the students from 1<sup>st</sup> to 8<sup>th</sup> grade language, mathematics and understanding of the natural environment.

Once again, in this article the question of impact evaluation refers to the third point, that is, the impact upon the performance in the SIMCE tests due to the lack of information to evaluate the other intermediate impacts.

**Illustration 2. Chain of results of the ICT in the Classroom Program for students in 1<sup>st</sup> to 8<sup>th</sup> grade in Subsidized Educational Institutions – SEIs- (2007-2011).**



## 4. METHODOLOGY OF THE STUDY

### 4.1 Conceptual Framework and Available Information

The impact is estimated following the chain of results presented above (illustrations 1 and 2). The analysis of the available information is centered on the final results, specifically on the scores obtained by the students in the SIMCE test in 4<sup>th</sup> and 8<sup>th</sup> grade in language and mathematics.

The SIMCE test results at the student level, that includes context information for the teachers, students, parents and representatives, were combined with the monitoring data for the programs obtained from ENLACES. With this in principle a panel database at the EI level was obtained with at least two measurements in time: a base line for 4<sup>th</sup> grade and follow-up for 8<sup>th</sup> grade. When incorporating the information at the student level, where their identification is not possible so they are not necessarily the same students, a repeated cross section database was obtained, which are called cohorts, because it deals with the same group of students that took the test in 4<sup>th</sup> and 8<sup>th</sup> grade; at this level the EIs were used as clusters. Table 2 summarizes the available information that was used as the base line and follow-up in each one of the programs. In the rest of the article the option to evaluate the programs at the cohort level is used.

**Table 2. Base Line and Follow-up for the Cohorts evaluated**

Program	Cohort evaluated	Base line	Follow-up
Funds for broadband (2006-2008r)*	2005-2009	SIMCE 4 <sup>th</sup> grade 2005	SIMCE 8th grade 2009
ICT in the classroom (2007-2011)	2007-2011	SIMCE 4 <sup>th</sup> grade 2007	SIMCE 8th grade 2011

\* The SEI (treated and control) that participated in the 2009-2010 period were excluded from the sample.

With regard to the dependent variables, the decision was made following the usual practice in literature to work with standardized scores. However, Table 3 also summarizes the levels reached by the variable before the standardization of the samples analyzed in each program.

**Table 3. Descriptive Statistics for SIMCE Score**

FBA Program 2006-2008r					
Variable	Obs.	Average	Std dev.	Min.	Max.
Language	149162	252.45	51.11	98.00	378.08
Mathematics	148964	251.42	52.27	90.70	402.42
Standardized language	149162	0.00	1.00	-3.02	2.46
Standardized mathematics	148964	0.00	1.00	-3.07	2.89
ICT-AU Program 2007-2011					
Variable	Obs.	Average	Std dev.	Min.	Max.
Language	187194	240.76	49.71	104.81	379.35
Mathematics	187219	236.30	49.89	87.10	395.66
Standardized language	187194	0.00	1.00	-2.73	2.79
Standardized mathematics	187219	0.00	1.00	-2.99	3.19

## 4.2 Description of the Study Groups

The treatment group is the SEIs that were actual beneficiaries of each one of the programs, that is to say that in accordance with the ENLACES monitoring information had an “Approved” status for the authorization, implementation or use of the services/products delivered. The control group is formed by those SEIs that although complying with the application requirements of the programs have not been actual beneficiaries of the program, whether because they did not apply, applied and were not selected or were disapproved at some stage of the process.

Both groups were identified and selected from the monitoring data base provided by ENLACES. The types of SEIs considered by both groups were the following in accordance with each Program:

- ❖ Funds for Broadband: SEIs (particular or municipal) that provide basic cycle or middle school education.
- ❖ ICT in the Classroom: SEIs that provide basic cycle education.

Those EIs that did not have average language and/or mathematics scores at the EI level were excluded from both groups as a result of the criteria defined by SIMCE: less than 6 students or that the students that took the test did not represent the respective course.

## 5. THE MODEL

According to the ENLACES monitoring information the benefits were not delivered at random, but rather through an invitation, delivery and monitoring process. This process is a source of selection bias and due to the educational dynamic produces temporal variations.

At the EI level, a Probit model of participation in each program was estimated using the base line data:

$$P_i = \alpha_0 + \sum \beta_i R_i + \gamma A_i + \delta DE_i + \sum \varphi_i GSE_i + \varepsilon_i \quad (1)$$

Where:  $R_i$  is a dummy variable for identifying regions,  $A_i$  is an area dummy (urban/rural),  $DE_i$  is a dependency dummy (Subsidized Private vs. Municipal) and finally  $GSE_i$  is a dummy that categories the socio-economic group of the EI. Based on this model the probability of participating in each program was obtained, then the common support area was graphed and then used in the impact estimation. It was not necessary to restrict the samples for this concept since the support of treated and non-treated in both programs was similar, as is shown in Annex 1.

An evaluation cohort was selected for each program, composed of repeated cross section data at the student level. Given this a regression model for estimating the impact using the difference -in-differences method<sup>13</sup> was created, therefore:

$$Y_{it} = \beta_0 + \beta_1 P_i + \beta_2 T + \beta_3 PT + \sum \beta_{k+3} X_{kit} + \varepsilon_{it} \quad (2)$$

Where:

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<sup>13</sup> Model 2 can be created with difference using panel data and two periods:  $\Delta Y_i = \beta_0 + \beta_1 P_i + \sum \beta_{k+1} X_{ki} + v_i$ , where in this case  $\beta_1$  would be the impact parameter. For multiple periods model (2) would become a fixed effects model:

$$Y_{it} = \beta_0 + \beta_1 P_{it} + \sum \beta_{k+1} X_{kit} + \sum \gamma_N E_N + \sum \delta_T T_T + \varepsilon_{it}$$

$Y_{it}$  = standardized score of the student  $i$  in the period  $t$  in a specific cohort (2005-2009, 2007-2011) and specific learning sector (language or mathematics).

$P_i$  = dichotomous variable that indicates the treatment group (1) or control group (0) for each one of the programs, whose associated parameter ( $\beta_1$ ) measures the difference in the base line.

$T$  is a variable of time (1=post, 0=pre) and the associated parameter ( $\beta_2$ ) measures the changes in time.

$P_iT$  is the interaction between the program and time, whose associated parameter ( $\beta_3$ ) measures the real impact of the program.

$X_{kit}$  = set of control variables of the base line and/or that change over time that can affect the result variable. Two groups of variables were considered: variables associated with the EI such as the dependency (Municipal, Subsidized Private) and the socio-economic group (low, medium-low, medium, medium-high and high); variables associated with the student and his/her home (gender, education of the parents, entrance to the home, number of books at home, use of computer at home and connection to internet at home).

$\varepsilon_{it}$  = error term

To study the combined impact of both programs the model was expanded to include the main effect and interactions:

$$Y_{it} = \beta_0 + \beta_1 P1_i + \beta_2 P2_i + \beta_3 T + \beta_4 P1_i P2_i + \beta_5 P1_i T + \beta_6 P2_i T + \beta_7 P1_i P2_i T + \sum \beta_{k+7} X_{kit} + \varepsilon_{it} \quad (3)$$

Where  $\beta_5$  and  $\beta_6$  measures the individual impact of each program and  $\beta_7$  measures the combined impact or interaction of both.

Finally, models 2 and 3 were also estimated using the inverse of the probability of participating in each program, obtained from model 1 as the weighting factor. This method is known as difference in differences with matching.

## 6. RESULTS

### 6.1 Funds for broadband (2006-2010)

The results of the impact estimate of the Funds for Broadband program are presented below for a cohort of students that in 2005 were in 4<sup>th</sup> grade. The SIMCE test results for this year were used as the base line; as follow-up the SIMCE test results for 2009 were used, for the same cohort of students in 8<sup>th</sup> grade.

Those educational institutions that participated at least once between the period 2006 and 2008 were considered as indicator of participation in the program (treated). The control group was comprised of those invited to participate by ENLACES but that did not apply or after the entire selection process did not receive benefits.

Table 4 presents a comparison of some observable variables of the base line in both participant groups. As was to be expected, only in four of the 20 variables included (EI in metropolitan region, subsidized private vs. Municipal EI, Medium-Low Socioeconomic Group and Homes with more than 50 books) significant differences were not observed between the treatment and the control group. In light of this evidence that shows there is no balance between the groups, it can be concluded that it is not enough to just analyze the simple difference between the groups after the treatment but rather it is necessary to do a difference in differences analysis. However, for the purpose of guaranteeing that an approximation of differences in differences will provide us valid information for the impact of the program, parallel tendency tests between groups before the exposition to the program also have to be carried out. The results of these tests are presented in Annex 3 and show that, indeed, non-parallel tendencies between the groups were not detected.

Tables 5 and 6 show a direct comparison of the standardized scores between groups (treated and control) and between periods (2005 and 2009) for the restricted sample (r), that is, those that actually participated whether in the treated group or in the control group during the period. Even though better results were observed in language as well as in mathematics in the treated group with respect to the control, the difference in differences is not significant, which suggests a low impact of the program.

Table 7 shows the results of the estimation of the impact of the program on the two variables of interest: standardized SIMCE test score in language and in mathematics. The final specifications of equation 2

indicated in the methodology section are presented using two approximations: standard difference in differences and difference in differences with matching, model in which the probability of a SEIs participating in the program has been estimated by means of a Probit and the estimation has been done weighting the observations by the inverse of this probability.<sup>14</sup>

As can be seen in this Table, the impact variable (Program\*Time) is not statistically significant at 5%. A fall over time in the Language scores and an increase in Mathematics is confirmed which are both significant. In addition a positive and significant effect was found for Educational Institutions with a greater socioeconomic level, for homes with higher income, homes with a computer, the presence of more books in the home and the education of the parents, the education of the mother having a greater effect. It is interesting to note that the positive effect of having a computer in the home contrasts with a negative and significant effect of having internet. Finally, the female student has a higher score in language but lower in mathematics, both significant.

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<sup>14</sup> A statistical Annex has been created, available from the authors, in which the sequence of these difference in differences with and without matching models for language as well as mathematics are presented where the models selected are precisely the SM and CM models reported in Table 7.



**Table 4. Evaluation of the Base Line for the Broadband Program Fund: variables of the SIMCE test results for 4<sup>th</sup> grade in 2005.**

Variable	Control (C)	Treated (T)	Difference (T-C)
North Regions (% EI)	4.98 (0.72)	2.21 (0.49)	-2.77*** (0.87)
Metropolitan Region (% EI)	36.62 (1.60)	39.82 (1.63)	3.21 (2.28)
Center Regions (% EI)	25.11 (1.44)	30.20 (1.53)	5.09** (2.10)
South Regions (% EI)	33.30 (1.57)	27.77 (1.49)	-5.53** (2.16)
Urban Areas (% EI)	54.76 (1.66)	89.05 (1.04)	34.29*** (1.95)
Subsidized Private Dependency (% EI)	47.79 (1.66)	52.32 (1.66)	4.54 (2.35)
Low Socioeconomic Group (% EI)	29.98 (1.52)	5.53 (0.76)	-24.45*** (1.70)
Medium-Low Socioeconomic Group (% EI)	34.62 (1.58)	37.83 (1.61)	3.21 (2.26)
Medium Socioeconomic Group(% EI)	19.03 (1.31)	33.85 (1.57)	14.82*** (2.04)
Medium-High Socioeconomic Group(% EI)	16.37 (1.23)	22.79 (1.40)	6.42*** (1.86)
Average Household Income per month (\$ chilean)	247781 (1408)	233290 (1097)	-14490*** (1785)
Average education of the father in home of student (years)	10.74 (0.02)	10.80 (0.02)	0.06** (0.03)
Average education of the mother in home of student (years)	10.68 (0.02)	10.78 (0.02)	0.09** (0.03)
Home with more than 50 books (% Students)	12.62 (0.18)	12.28 (0.15)	-0.34 (0.23)
Homes with computer (% Students)	36.70 (0.27)	35.36 (0.23)	-1.34*** (0.35)
Homes with internet (% Students)	13.01 (0.19)	11.00 (0.15)	-2.01*** (0.24)
Females with score (% Students)	48.55 (0.27)	50.28 (0.23)	1.73*** (0.36)
Language and Communication Score (average)	253.70 (0.29)	255.86 (0.24)	2.16*** (0.38)
Mathematics Score (average)	245.43 (0.30)	247.86 (0.25)	2.16*** (0.38)
Understanding of the Environment Score (average)	255.52 (0.29)	257.46 (0.24)	1.93*** (0.38)
Number of Establishments	904	904	
Number of Students with Score	33443	46082	

\*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 5. Cross table of standardized averages: Language**

FBA Program 2006-2008r	2005	2009	Difference
Control	0.025 (0.005)	-0.089 (0.006)	-0.114*** (0.008)
Treated	0.067 (0.005)	-0.032 (0.005)	-0.099*** (0.007)
Difference	0.042*** (0.007)	0.057*** (0.008)	0.015 (0.010)

Standard errors in brackets. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 6. Cross Table of standardized averages: Mathematics**

FBA Program 2006-2008r	2005	2009	Difference
Control	-0.115 (0.005)	0.077 (0.006)	0.192*** (0.008)
Treated	-0.068 (0.005)	0.118 (0.005)	0.186*** (0.007)
Difference	0.046*** (0.007)	0.042*** (0.008)	-0.005 (0.010)

Standard errors in brackets. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

Annex 2 contains a graphic analysis, complementary to Tables 5 and 6 associated to the direct comparison between groups, before and after treatment.

**Table 7. Funds for Broadband Impact Estimation for SIMCE tests: Final Models (Standardized scores)**

Variable	Language		Mathematics	
	SM Model	CM Model	SM Model	CM Model
<b>FBA X Year</b>	<b>0.03</b> <b>(0.02)</b>	<b>-0.003</b> <b>(0.02)</b>	<b>0.005</b> <b>(0.02)</b>	<b>-0.013</b> <b>(0.02)</b>
FBA 2006-08r	0.02 (0.02)	0.022 (0.02)	0.033 (0.02)	0.036 (0.02)
Year	-0.154*** (0.02)	-0.128*** (0.02)	0.160*** (0.02)	0.173*** (0.02)
Urban area	-0.169*** (0.02)	-0.146*** (0.02)	-0.134*** (0.02)	-0.104*** (0.03)
EI Subsidized Private	0.02 (0.02)	0.004 (0.02)	0.036 (0.02)	0.024 (0.02)
Med.-Low Soc.-Econ. Group	0.074** (0.02)	0.104*** (0.03)	0.089*** (0.03)	0.122*** (0.03)
Med. Soc.-Econ. Group	0.337*** (0.03)	0.378*** (0.03)	0.362*** (0.03)	0.406*** (0.04)
Med.-High Soc.-Econ. Group	0.553*** (0.03)	0.595*** (0.04)	0.601*** (0.04)	0.643*** (0.04)
Household income (ln \$)	0.042*** (0.01)	0.046*** (0.01)	0.057*** (0.01)	0.060*** (0.01)
Father's educ. (years)	0.020*** (0.001)	0.020*** (0.001)	0.019*** (0.001)	0.020*** (0.001)
Mother's educ. (years)	0.027*** (0.001)	0.025*** (0.001)	0.025*** (0.001)	0.024*** (0.001)
Books in home (1 to 10)	0.096*** (0.01)	0.105*** (0.02)	0.082*** (0.01)	0.089*** (0.01)
Books in home (11 to 50)	0.216*** (0.01)	0.229*** (0.02)	0.190*** (0.01)	0.202*** (0.02)
Books in home (51 to 100)	0.302*** (0.02)	0.317*** (0.02)	0.271*** (0.02)	0.281*** (0.02)
Books in home (> 100)	0.365*** (0.02)	0.371*** (0.02)	0.333*** (0.02)	0.335*** (0.02)
Computer in home	0.079*** (0.01)	0.081*** (0.01)	0.072*** (0.01)	0.076*** (0.01)
Internet in home	-0.042*** (0.01)	-0.050*** (0.01)	-0.029** (0.01)	-0.034** (0.01)
Female student	0.169*** (0.01)	0.170*** (0.01)	-0.120*** (0.01)	-0.112*** (0.01)
Constant	-1.503*** (0.09)	-1.610*** (0.09)	-1.681*** (0.11)	-1.800*** (0.11)
R2	0.152	0.16	0.169	0.183
Control Regions	Yes	Yes	Yes	Yes
Value-p>F	0.00	0.00	0.00	0.00
Observations	110888	110888	111275	111275

Standard errors adjusted by clustering effect of educational institution (EI). \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. SM: Difference in Differences Model without Matching. CM: Difference in Differences Model with Matching, weighting by the inverse of the probability of participating, using a Probit model at the EI level.

## 6.2 ICT in the Classroom (2007-2011)

In this section we present the results of the estimate of impact of the ICT in the Classroom program for a cohort of students that in 2007 were in 4<sup>th</sup> grade. The SIMCE test results for this year were used as base line and as follow-up the SIMCE test results from 2011, for the same cohort of students in 8<sup>th</sup> grade.

As indicator of participation in the program (treated) those educational institutions that participated at least once between the period 2007 and 2011 were considered. The control group was those invited to participate by ENLACES, but that did not apply or after the entire selection process did not receive benefits.

Table 8 shows a comparison of some variables that can be observed in the base line for both participant groups. In this case significant differences between the treatment group and the control group were not observed only in 6 of the 19 variables (Region North, Medium-High Socioeconomic Group, Homes with more than 50 books, Homes with computers, Homes with internet and Females with scores). Just like in the case of the previous program, this evidence shows that there is no balance between the treated and control groups, which implies that it is not enough to just analyze the simple difference between the groups after the treatment, but rather a difference in differences analysis has to be done. However, in order to guarantee an appropriate approximation of difference in differences, parallel tendencies tests should be done before the exposure to the program. The results of these tests are shown in Annex 3 and show that, indeed non-parallel tendencies between the groups were not detected.

Tables 9 and 10 show a direct comparison of the standardized scores between groups (treated and control) and between periods (2007 and 2011). The data suggests that in mathematics an improvement in the performance of the period has occurred and a decrease in language. It is also observed that there is a significant difference in the performance of groups in favor of the treated group, but the net effect of the program is not significant.

Table 11 shows the results of the impact estimation for the ICT in the Classroom program for the variables of interest: standardized score of the SIMCE test in language and mathematics. Just like in the Broadband case, the final specifications for equation 2 indicated in the methodology are shown using two approximations: standard difference in differences and difference in differences with matching (SM and CM Models,

respectively). In this last case the probability of a SEIs participating in the program has been estimated using a Probit, and the estimation has been done weighting the observations by the inverse of this probability.<sup>15</sup>

As can be seen in the Table, for language as well as mathematics, the impact variable (Program\*Time) was positive but not significant at 5%, for the difference in differences model with and without matching. Significant differences between groups were not detected but a fall over time in the Language scores and rise in Mathematics were observed, both significant. In addition a positive and significant effect was found for the Educational Institutions with a higher socio-economic level, with higher income, with access to computer at home, with presence of more books at home and with education of the parents, the education of the mother having a greater effect. It is interesting to note that once again the positive effect of having a computer at home contrasts with the negative and significant effect of having access to the internet. Female students have a higher score in language, but lower in mathematics both significant effects. Finally the belonging of the institution to an urban area has a negative and significant effect.

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<sup>15</sup> In the statistical Annex, available with the authors, the sequence of these difference in differences models without and with matching are presented for language as well as mathematics, where the models selected are precisely the SM and CM models reported in Table 11.

**Table 8. Evaluation of the Base Line for the ICT in the Classroom Program: variables of the SIMCE tests results for 4<sup>th</sup> grade in 2007**

Variable	Control (C)	Treated (T)	Difference (T-C)
North Regions (% EE)	6.63 (0.60)	8.28 (0.95)	1.66 (1.12)
Metropolitan Region (% EE)	22.40 (1.01)	18.22 (1.33)	-4.18** (1.67)
Center Regions (% EE)	39.30 (1.18)	28.40 (1.55)	-10.89*** (1.95)
South Regions (% EE)	31.67 (1.13)	45.09 (1.71)	13.42*** (2.05)
Urban Areas (% EE)	57.13 (1.20)	75.74 (1.47)	18.61*** (1.90)
Low Soc.- Econ. Group (% EE)	32.55 (1.13)	1870 (1.34)	-13.85*** (1.76)
Med.-Low Soc.-Econ. Group	49.21 (1.21)	55.86 (1.71)	6.65*** (2.09)
Med. Soc.-Econ. Group	16.77 (0.90)	23.67 (1.46)	6.89*** (1.72)
Med.-High Soc.-Econ. Group	1.47 (0.29)	1.78 (0.45)	0.31 (0.54)
Average Household income per month (In Chilenos \$)	206268 (778)	203729 (971)	-2539** (1245)
Average Father's educ. (years)	9.90 (0.01)	10.05 (0.02)	0.16*** (0.02)
Average Mother's educ. (years)	9.82 (0.01)	9.96 (0.02)	0.14*** (0.02)
Households with more than 50 books (% Students)	7.40 (0.10)	7.40 (0.12)	0.00 (0.16)
Homes with computers (% Students)	34.07 (0.19)	34.63 (0.25)	0.56 (0.31)
Homes with internet (% Students)	11.30 (0.13)	11.39 (0.17)	0.09 (0.21)
Females with scores (% Students)	49.13 (0.20)	49.03 (0.25)	-0.10 (0.32)
Language and Communication score (average)	239.76 (0.21)	243.89 (0.26)	4.12*** (0.33)
Mathematics score (average)	229.54 (0.22)	233.60 (0.28)	4.05*** (0.35)
Understanding of Environment score (average)	234.11 (0.19)	237.88 (0.24)	3.76*** (0.31)
Number of Establishments	1553	833	
Number of Students with scores	61923	38020	

Standard errors in brackets. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 9. Cross table of standardized averages: Language**

ICT in the Classroom 2007-2011r	2007	2011	Difference
Control	-0.020 (0.004)	-0.044 (0.004)	-0.024*** (0.006)
Treated	0.063 (0.005)	0.035 (0.005)	-0.028*** (0.007)
Difference	0.083*** (0.007)	0.079*** (0.007)	-0.004 (0.010)

Standard errors in brackets. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

**Table 10. Cross table of standardized averages: Mathematics**

ICT in the Classroom 2007-2011r	2007	2011	Difference
Control	-0.135 (0.004)	0.092 (0.004)	0.227*** (0.006)
Treated	-0.054 (0.005)	0.164 (0.005)	0.218*** (0.007)
Difference	0.081*** (0.006)	0.072*** (0.007)	-0.009 (0.009)

Standard errors in brackets. \*\*\* p<0.01; \*\* p<0.05; \* p<0.1

Annex 2 contains a graphic analysis, complementary to Tables 9 and 10, associated with the direct comparison between groups, before and after treatment.

**Table 11. ICT in the Classroom Impact Estimation for SIMCE tests: Final model (Standardized scores)**

Variable	Language		Mathematics	
	SM Model	CM Model	SM Model	CM Model
<b>ICT X Year</b>	<b>0.023</b>	<b>0.037</b>	<b>0.023</b>	<b>0.035</b>
	(0.02)	(0.02)	(0.02)	(0.02)
ICT 2007-11	0.021	0.012	0.023	0.005
	(0.02)	(0.02)	(0.02)	(0.02)
Year	-0.100***	-0.106***	0.144***	0.144***
	(0.01)	(0.01)	(0.01)	(0.01)
Urban Area	-0.204***	-0.212***	-0.155***	-0.160***
	(0.02)	(0.02)	(0.02)	(0.02)
Med.-Low Soc.-Econ. Group	0.035	0.039	0.040*	0.045
	(0.02)	(0.02)	(0.02)	(0.02)
Medium Soc.-Econ. Group	0.190***	0.204***	0.214***	0.221***
	(0.02)	(0.03)	(0.02)	(0.03)
Med.-High Soc.-Econ. Group	0.509***	0.530***	0.626***	0.650***
	(0.06)	(0.06)	(0.06)	(0.07)
Household Income (ln\$)	0.038***	0.038***	0.056***	0.055***
	(0.001)	(0.01)	(0.001)	(0.01)
Father's Education (years)	0.018***	0.017***	0.016***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)
Mother's Education (years)	0.028***	0.027***	0.030***	0.030***
	(0.001)	(0.001)	(0.001)	(0.001)
Books in home (1 to 10)	0.085***	0.080***	0.095***	0.096***
	(0.01)	(0.01)	(0.01)	(0.01)
Books in home (11 to 50)	0.201***	0.195***	0.219***	0.216***
	(0.01)	(0.01)	(0.01)	(0.01)
Books in home (51 to 100)	0.310***	0.306***	0.322***	0.320***
	(0.01)	(0.02)	(0.01)	(0.02)
Books in home (> 100)	0.370***	0.363***	0.381***	0.386***
	(0.02)	(0.02)	(0.02)	(0.02)
Computer in home	0.177***	0.175***	0.197***	0.197***
	(0.01)	(0.01)	(0.01)	(0.01)
Internet in home	-0.046***	-0.042***	-0.085***	-0.086***
	(0.01)	(0.01)	(0.01)	(0.01)
Female student	0.199***	0.199***	-0.096***	-0.094***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	-1.375***	-1.354***	-1.618***	-1.591***
	(0.07)	(0.07)	(0.07)	(0.08)
R2	0.105	0.105	0.117	0.118
Control Regions	Yes	Yes	Yes	Yes
Values-p>F	0.00	0.00	0.00	0.00
Observations	133413	133413	134044	134044

Standard errors adjusted by clustering effect of educational institution (EI). \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. SM: Difference in differences model without matching. CM: Difference in differences model with matching, weighting by the inverse of the probability of participating, using a Probit model at the EI level.



### 6.3 Effect of the interaction of the programs

Given the absence of significant impacts of the programs on a separate basis, it is worth asking if it is possible whether there is a significant impact from the interaction between both programs. Table 12 shows the main results obtained with a sample constructed with the 2005-2009 cohort. Similarly, Table 13 shows the results for the 2007-2011 cohort. It can be observed that the interaction is not significant. In addition the main results of the prior sections are confirmed.

**Table 12. Effect of Interaction of FBA and ICT in the Classroom in cohort 4<sup>th</sup> grade 2005 and 8<sup>th</sup> grade 2009**

Variable	Language		Mathematics	
	SM Model	CM Model	SM Model	CM Model
<b>FBA X ICT X Year</b>	<b>-0.046</b> <b>(0.08)</b>	<b>-0.169</b> <b>(0.13)</b>	<b>-0.079</b> <b>(0.10)</b>	<b>-0.158</b> <b>(0.12)</b>
<b>FBA X Year</b>	<b>0.054</b> <b>(0.04)</b>	<b>0.023</b> <b>(0.05)</b>	<b>0.024</b> <b>(0.04)</b>	<b>-0.013</b> <b>(0.06)</b>
<b>ICT X Year</b>	<b>-0.069</b> <b>(0.06)</b>	<b>0.047</b> <b>(0.08)</b>	<b>-0.012</b> <b>(0.08)</b>	<b>0.005</b> <b>(0.07)</b>
FBA 2006-08r	-0.036 (0.03)	-0.088 (0.05)	-0.022 (0.03)	-0.062 (0.05)
ICT 2007-09r	0.023 (0.06)	0.106 (0.18)	0.024 (0.07)	0.112 (0.15)
Year	-0.121*** (0.03)	-0.124** (0.04)	0.122*** (0.03)	0.147** (0.05)
FBA X ICT	-0.022 (0.08)	-0.079 (0.18)	0.039 (0.09)	0.018 (0.17)
Urban area	-0.183*** (0.03)	-0.166*** (0.05)	-0.142*** (0.03)	-0.119* (0.05)
Med.-Low Soc.-Econ. Group	0.065* (0.03)	0.152** (0.05)	0.057 (0.03)	0.156** (0.05)
Medium Soc.-Econ. Group	0.320*** (0.04)	0.424*** (0.06)	0.314*** (0.04)	0.453*** (0.07)
Med.-High Soc.-Econ. Group	0.740*** (0.09)	0.838*** (0.10)	0.799*** (0.11)	0.958*** (0.13)
Household income (ln\$)	0.052*** (0.01)	0.077*** (0.02)	0.067*** (0.01)	0.074*** (0.02)
Father's Education (Years)	0.024*** (0.001)	0.018*** (0.001)	0.023*** (0.001)	0.014*** (0.001)
Mother's Education (Years)	0.028*** (0.001)	0.025*** (0.01)	0.028*** (0.001)	0.024*** (0.001)
Books in home (1 to 10)	0.074*** (0.02)	0.057 (0.05)	0.066*** (0.02)	0.039 (0.04)
Books in home (11 to 50)	0.208*** (0.02)	0.240*** (0.06)	0.173*** (0.02)	0.209*** (0.04)
Books in home (51 to 100)	0.277*** (0.03)	0.334*** (0.06)	0.265*** (0.03)	0.285*** (0.05)
Books home (> 100)	0.315*** (0.03)	0.343*** (0.06)	0.280*** (0.03)	0.328*** (0.05)
Computer s in home	0.064*** (0.01)	0.04 (0.03)	0.079*** (0.01)	0.069* (0.03)
Internet in home	-0.040* (0.02)	-0.065* (0.03)	-0.043* (0.02)	-0.076** (0.03)
Female student	0.179*** (0.01)	0.155*** (0.02)	-0.114*** (0.01)	-0.111*** (0.02)
Constant	-1.712*** (0.17)	-1.955*** (0.31)	-1.714*** (0.16)	-1.698*** (0.30)
R2	0.12	0.112	0.124	0.126
Control Regions	Yes	Yes	Yes	Yes
Value-p>F	0.00	0.00	0.00	0.00

Observations	36826	36826	36936	36936
Standard errors adjusted by clustering effect of educational institution (EI). * p<0.05, ** p<0.01, ***p<0.001. SM: Difference in differences model without matching. CM: Difference in differences model with matching, weighting by the inverse of the probability of participating, using a Probit model at the EI level.				

**Table 13. Effect of Interaction of FBA and ICT in the Classroom in Cohort 4<sup>th</sup> grade 2007 and 8<sup>th</sup> grade 2011**

Variable	Language		Mathematics	
	SM Model	CM Model	SM Model	CM Model
<b>FBA X ICT X Year</b>	<b>0.053</b> <b>(0.08)</b>	<b>0.049</b> <b>(0.09)</b>	<b>0.012</b> <b>(0.09)</b>	<b>-0.037</b> <b>(0.10)</b>
<b>FBA X Year</b>	<b>0.067</b> <b>(0.04)</b>	<b>0.082</b> <b>(0.05)</b>	<b>0.082*</b> <b>(0.04)</b>	<b>0.098*</b> <b>(0.05)</b>
<b>ICT X Year</b>	<b>0.046</b> <b>(0.06)</b>	<b>0.078</b> <b>(0.06)</b>	<b>0.017</b> <b>(0.07)</b>	<b>0.061</b> <b>(0.07)</b>
FBA 2009-10r	-0.079* (0.03)	-0.093* (0.04)	-0.056 (0.04)	-0.082 (0.05)
ICT 2007-11	0.074 (0.05)	0.047 (0.05)	0.081 (0.07)	0.036 (0.07)
Year	-0.177*** (0.03)	-0.191*** (0.03)	0.079** (0.03)	0.072* (0.03)
FBA X ICT	-0.144* (0.07)	-0.081 (0.08)	-0.166 (0.09)	-0.099 (0.10)
Urban Area	-0.125*** (0.03)	-0.117** (0.04)	-0.070* (0.04)	-0.028 (0.04)
Med.-Low Soc.-Econ. Group	0.032 (0.03)	0.003 (0.03)	0.05 (0.03)	0.001 (0.03)
Medium Soc.-Econ. Group	0.207*** (0.05)	0.184** (0.06)	0.218*** (0.05)	0.178** (0.06)
Med.-High Soc. Econ. Group	0.803*** (0.09)	0.779*** (0.10)	0.950*** (0.08)	0.911*** (0.09)
Household income (ln\$)	0.026** (0.01)	0.029* (0.01)	0.042*** (0.01)	0.046*** (0.01)
Father's Education (Years)	0.017*** (0.001)	0.016*** (0.001)	0.015*** (0.001)	0.014*** (0.001)
Mother's Education (Years)	0.032*** (0.001)	0.030*** (0.001)	0.034*** (0.001)	0.033*** (0.001)
Books in home (1 to 10)	0.092*** (0.02)	0.078** (0.02)	0.091*** (0.02)	0.091*** (0.03)
Books in home (11 to 50)	0.205*** (0.02)	0.201*** (0.03)	0.223*** (0.02)	0.218*** (0.03)
Books in home (51 to 100)	0.310*** (0.03)	0.304*** (0.04)	0.327*** (0.03)	0.319*** (0.03)
Books home (> 100)	0.382*** (0.03)	0.390*** (0.04)	0.416*** (0.04)	0.436*** (0.04)
Computer s in home	0.200*** (0.01)	0.196*** (0.02)	0.212*** (0.01)	0.209*** (0.02)
Internet in home	-0.059*** (0.02)	-0.067*** (0.02)	-0.102*** (0.02)	-0.108*** (0.02)
Female student	0.213***	0.206***	-0.081***	-0.089***

Constant	(0.01) -1.190*** (0.16)	(0.01) -1.154*** (0.18)	(0.01) -1.501*** (0.18)	(0.01) -1.428*** (0.20)
R2	0.122	0.132	0.138	0.151
Control Regions	Yes	Yes	Yes	Yes
Value-p>F	0.00	0.00	0.00	0.00
Observations	31204	31204	31372	31372

Standard errors adjusted by clustering effect of educational institution (EI). \* p<0.05, \*\* p<0.01, \*\*\*p<0.001. SM: Difference in differences model without matching. CM: Difference in differences model with matching, weighting by the inverse of the probability of participating, using a Probit model at the EI level.

## 6.4 Identification of the Heterogeneous Effects

In this section we concentrate on studying whether the non-significance in the impact of the programs on a separate basis can be reverted in specific SEI samples. In Table 14 the results of this exercise are given when analyzing the Funds for Broadband program and in Table 15 the results for ICT in the Classroom are reported.

The results for the total sample in Tables 14 and 15 obviously coincide with those reported in the models with matching in Tables 7 and 11 respectively.

**Table 14. Effects of the FBA program in specific samples. (Results of final models with matching).**

Sample	Cohort: 2005-2009	
	Language	Mathematics
Total	-0.003 (0,021)	-0.013 (0.022)
R.M.	0.042 (0.030)	-0.004 (0.033)
Regions	<b>-0.068*</b> <b>(0.028)</b>	<b>-0.026</b> <b>(0.027)</b>
Urban Area	0.038 (0.023)	0.008 (0.026)
Rural Area	<b>-0.122*</b> <b>(0.059)</b>	<b>-0.129*</b> <b>(0.060)</b>
Subsidized Private EI	-0.009 (0.028)	-0.016 (0.030)
Municipal EI	0.002 (0.031)	-0.012 (0.031)
Med. or Med. High Soc.- Econ. Group	0.012 (0.029)	-0.021 (0.032)
Low or Med. Low Soc.- Econ. Group	-0.021 (0.031)	-0.034 (0.035)
With computer in the home	0.013 (0.025)	0.003 (0.028)
Without computer in the home	-0.029 (0.026)	-0.037 (0.026)

With internet in the home	0.032 (0.034)	0.020 (0.037)
Without internet in the home	-0.037 (0.023)	-0.038 (0.023)

In brackets the standard errors adjusted for clustering effect of the educational institution (EI). \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**Table 15. Effects of the ICT in the Classroom program in specific samples. (Results of final models with matching).**

Sample	Cohort: 2007-2011	
	Language	Mathematics
Total	0.037 (0.020)	0.035 (0.021)
R.M.	0.067 (0.043)	0.058 (0.047)
Regions	0.017 (0.022)	0.024 (0.022)
Urban Area	0.024 (0.022)	0.034 (0.023)
Rural Area	<b>0.104*</b> <b>(0.046)</b>	0.044 (0.049)
Med. or Med. High Soc.- Econ. Group	-0.001 (0.045)	0.047 (0.047)
Low or Med. Low Soc.- Econ. Group	<b>0.056*</b> <b>(0.024)</b>	0.037 (0.025)
With computer in the home	0.029 (0.024)	0.036 (0.025)
Without computer in the home	0.045 (0.024)	0.024 (0.025)
With internet in the home	0.045 (0.036)	0.028 (0.038)
Without internet in the home	<b>0.042*</b> <b>(0.021)</b>	0.035 (0.022)

In brackets the standard errors adjusted for clustering effect of the educational institution (EI). \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Table 14 shows that in rural regions and areas, the impact of the FBA program is negative and significant at 5%, with the exception of the effect in mathematics in regions, which is negative but not significant. A different situation is observed in Table 15, where in rural areas, low or medium low socioeconomic groups and homes without internet, the ICT in the Classroom program presents positive and significant impacts at 5% in language, but non-significant results for any sample in mathematics.

## 7. CONCLUSION

The impact of two initiatives of the Ministry of Education of Chile (MINEDUC) has been estimated: Funds for Broadband (2006-2010) and ICT in the Classroom (2007-2011) regarding the performance of the students in national tests established by the Education Quality Measurement System (SIMCE), available since 1998. Traditional evaluation techniques for impact evaluation of programs were used: difference in differences without and with matching, correcting by factors associated with observable and non-observable variables. The results show that it has not been possible to identify a significant impact of these programs, either separately or jointly. However, an analysis for specific groups reveals that ICT in the Classroom has a positive and significant impact on the teaching of language in rural areas, low or medium low socioeconomic groups and in students coming from a home without access to internet.

The analysis provides information beyond these programs, since access to internet at home shows in general a negative impact upon performance, but having a computer available at home has a positive and significant impact. These results in addition are consistent with those reported by Belo et al. (2010) for Portugal, which show that, even though connectivity actually generates a greater degree of efficiency in the teaching-learning process, the test results can fall due to the fact that the students can be distracted.

On the other hand, the Educational Institutions of a higher socioeconomic level, as well as students coming from homes with higher income, higher education of the parents, more books and with access to a computer obtain better results in the SIMCE. Finally females show a clear tendency to score higher in language and lower in mathematics in relation to males.

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# ANNEX 1: PARTICIPATION MODELS AND COMMON SUPPORT AREAS

## Participation in Funds for broadband (2006-2008r)

Probit regression

Number of obs = 81864

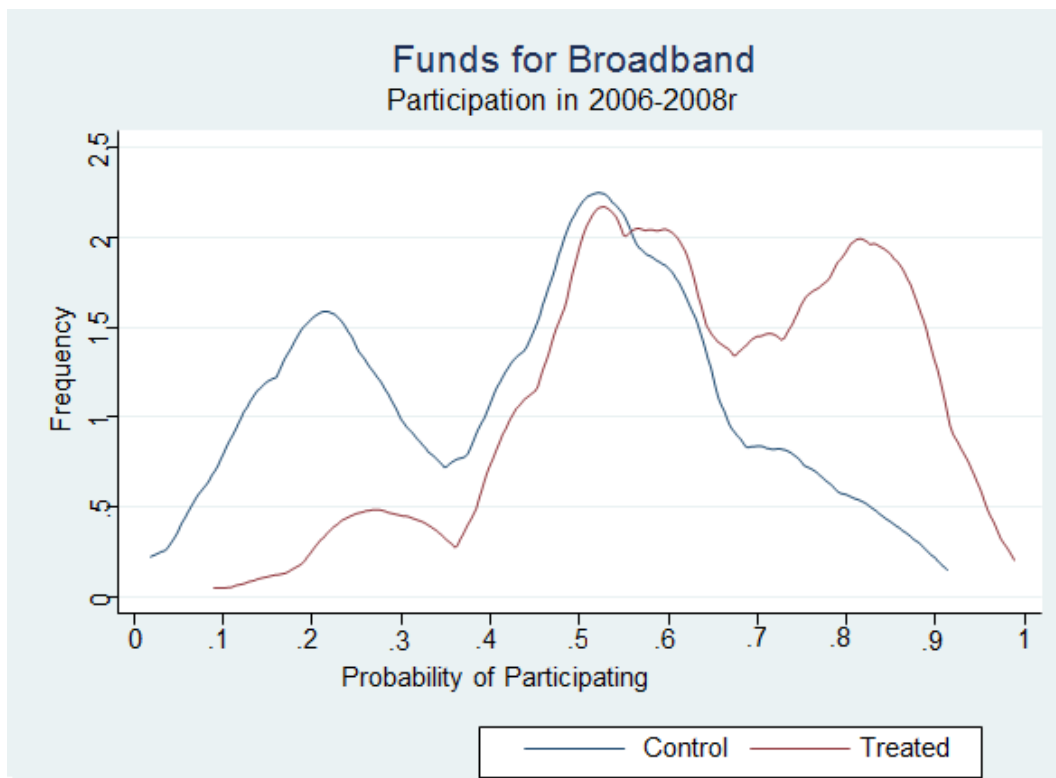
LR chi2(17) = 11608.49

Prob > chi2 = 0.0000

Log likelihood = -49651.478

Pseudo R2 = 0.1047

pfba_0608r	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_Iidregion_2	-.2117692	.0528778	-4.00	0.000	-.3154077	-.1081307
_Iidregion_3	-.5923154	.0663192	-8.93	0.000	-.7222986	-.4623321
_Iidregion_4	-.1049752	.0418177	-2.51	0.012	-.1869364	-.0230141
_Iidregion_5	1.217804	.0351272	34.67	0.000	1.148956	1.286652
_Iidregion_6	.8921947	.0351568	25.38	0.000	.8232887	.9611007
_Iidregion_7	.5026183	.0399769	12.57	0.000	.424265	.5809716
_Iidregion_8	.7535155	.0348477	21.62	0.000	.6852152	.8218158
_Iidregion_9	.7046498	.0374507	18.82	0.000	.6312479	.7780517
_Iidregion_10	.8966655	.0341622	26.25	0.000	.8297088	.9636222
_Iidregion_11	1.652946	.0957463	17.26	0.000	1.465286	1.840605
_Iidregion_12	2.109757	.1512004	13.95	0.000	1.813409	2.406104
_Iidregion_13	.170832	.0300719	5.68	0.000	.1118921	.2297719
urb	.7678438	.0179347	42.81	0.000	.7326924	.8029953
eepsub_05	-.2538223	.0117839	-21.54	0.000	-.2769183	-.2307263
gsemedbajo_05	.7811247	.0241556	32.34	0.000	.7337806	.8284688
gsemedio_05	.9532079	.0257375	37.04	0.000	.9027633	1.003653
gsemedalto_05	.7247417	.0268936	26.95	0.000	.6720313	.7774521
_cons	-1.518652	.0375756	-40.42	0.000	-1.592299	-1.445005



## Participation in ICT in the Classroom (2007-2011)

Probit regression

Log likelihood = -62056.187

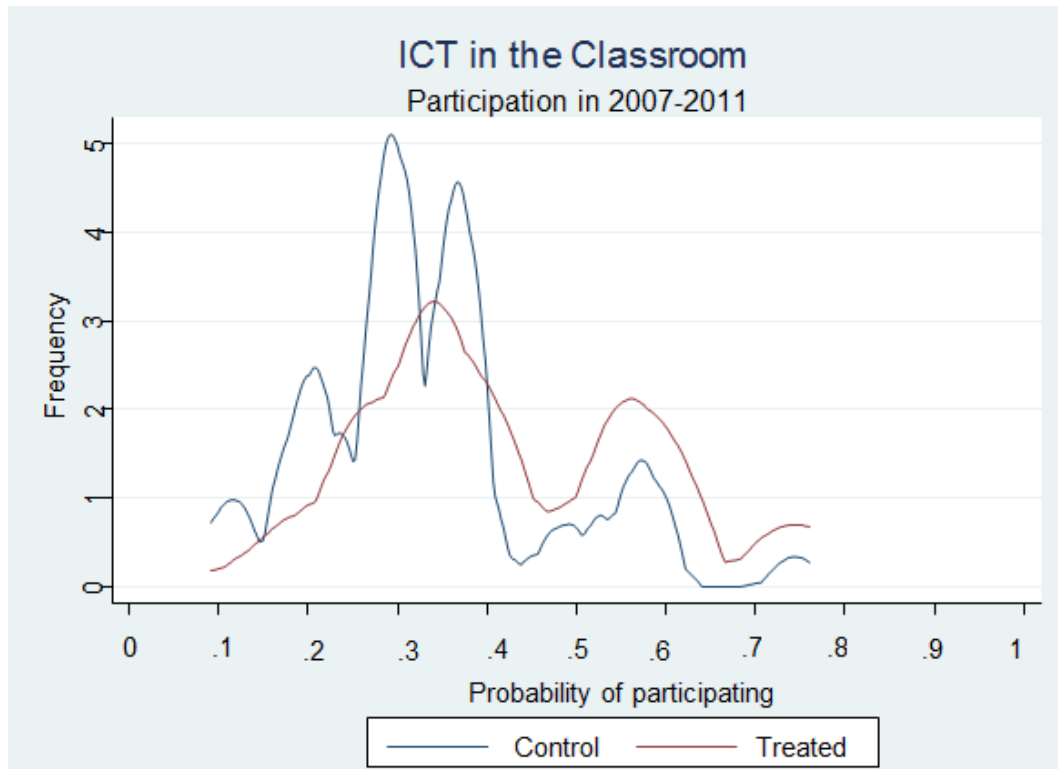
Number of obs = 99939

LR chi2(16) = 8661.63

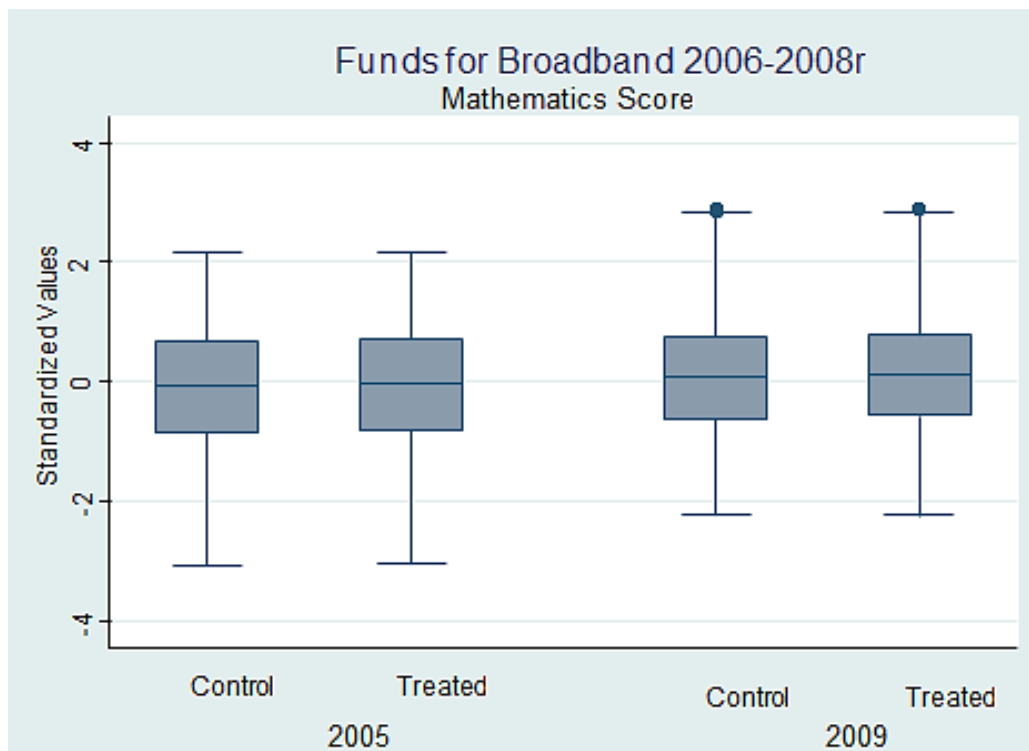
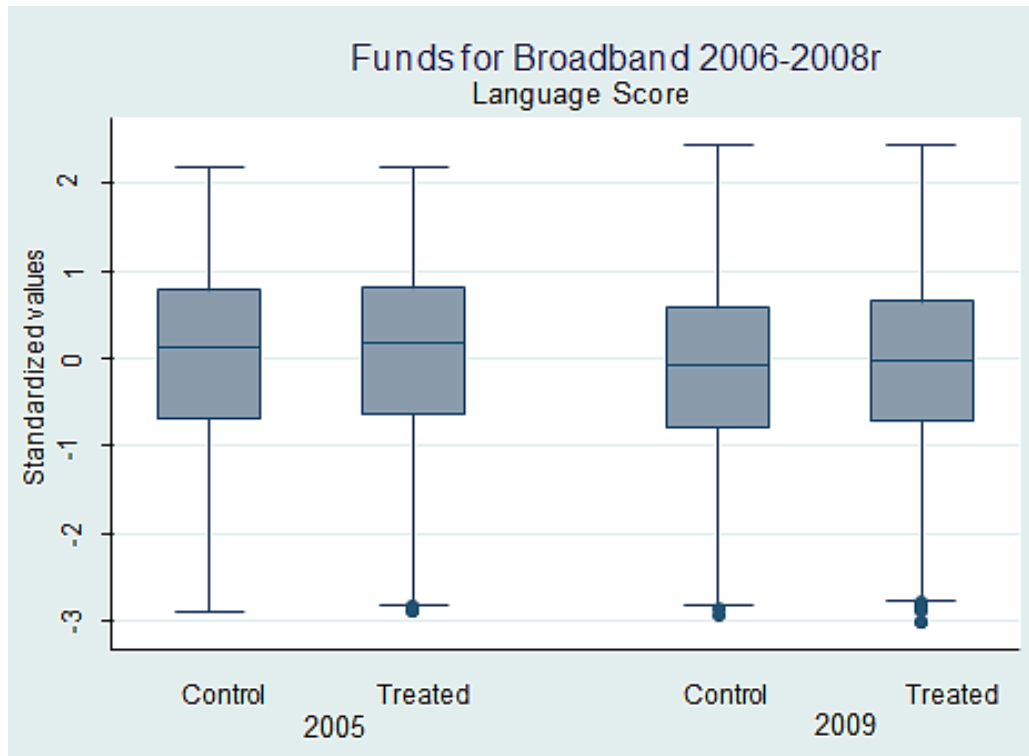
Prob > chi2 = 0.0000

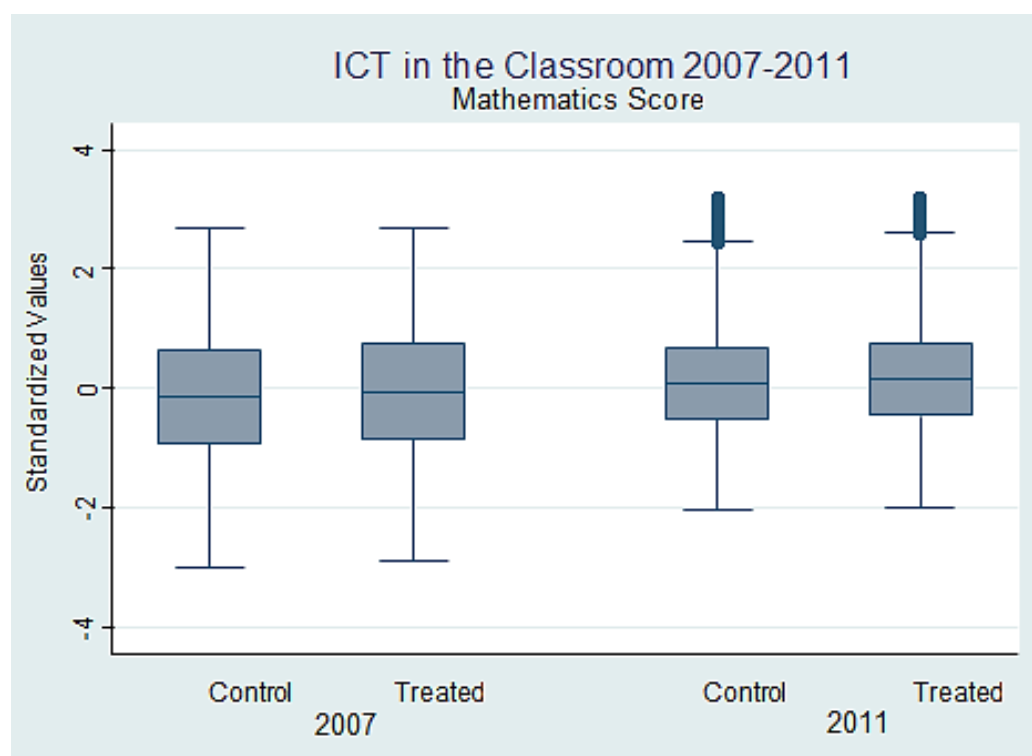
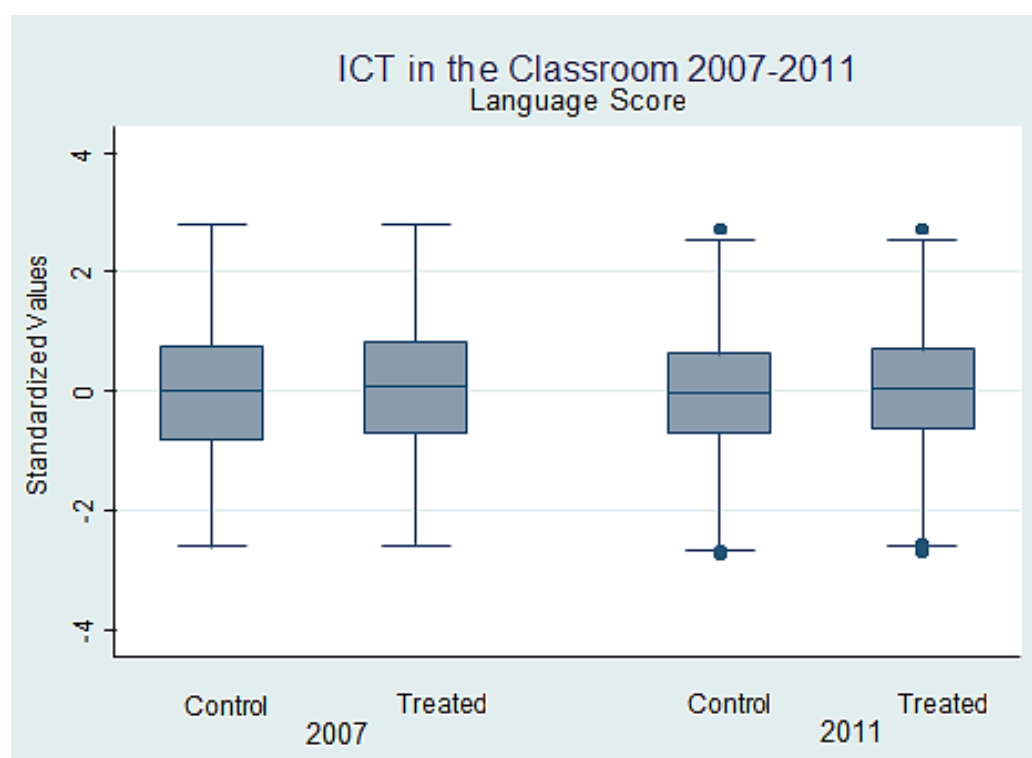
Pseudo R2 = 0.0652

pticau_0711	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_Iidregion_2	.4877851	.0337701	14.44	0.000	.4215969	.5539734
_Iidregion_3	.8539173	.0366396	23.31	0.000	.7821051	.9257295
_Iidregion_4	.4441007	.0348606	12.74	0.000	.3757752	.5124262
_Iidregion_5	.4518679	.0317692	14.22	0.000	.3896013	.5141344
_Iidregion_6	.0831106	.0337186	2.46	0.014	.0170234	.1491978
_Iidregion_7	.7773866	.0324304	23.97	0.000	.7138241	.8409491
_Iidregion_8	.9987106	.0307807	32.45	0.000	.9383816	1.05904
_Iidregion_9	1.451129	.0349811	41.48	0.000	1.382568	1.519691
_Iidregion_10	.4521802	.0323821	13.96	0.000	.3887124	.515648
_Iidregion_11	.6442579	.0525493	12.26	0.000	.5412632	.7472526
_Iidregion_12	-.1873674	.0496152	-3.78	0.000	-.2846115	-.0901234
_Iidregion_13	.2429008	.0299661	8.11	0.000	.1841682	.3016333
urb	.0706638	.0143046	4.94	0.000	.0426273	.0987002
gsemdbajo_07	.470988	.0166377	28.31	0.000	.4383786	.5035973
gsemedio_07	.5172947	.0182003	28.42	0.000	.4816227	.5529667
gsemedalto_07	.2560711	.0289578	8.84	0.000	.199315	.3128273
_cons	-1.329439	.0325358	-40.86	0.000	-1.393208	-1.26567



## ANNEX 2: DIRECT GRAPHIC ANALYSIS USING DIFFERENCE IN DIFFERENCES





## ANNEX 3: PARALLEL TENDENCY TEST

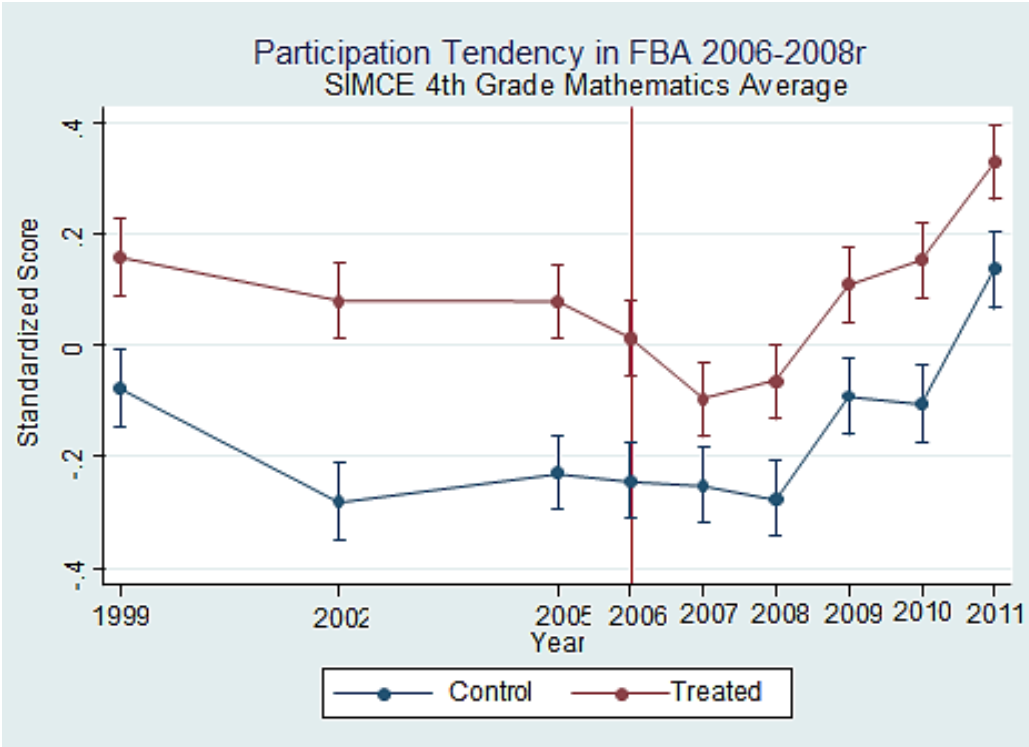
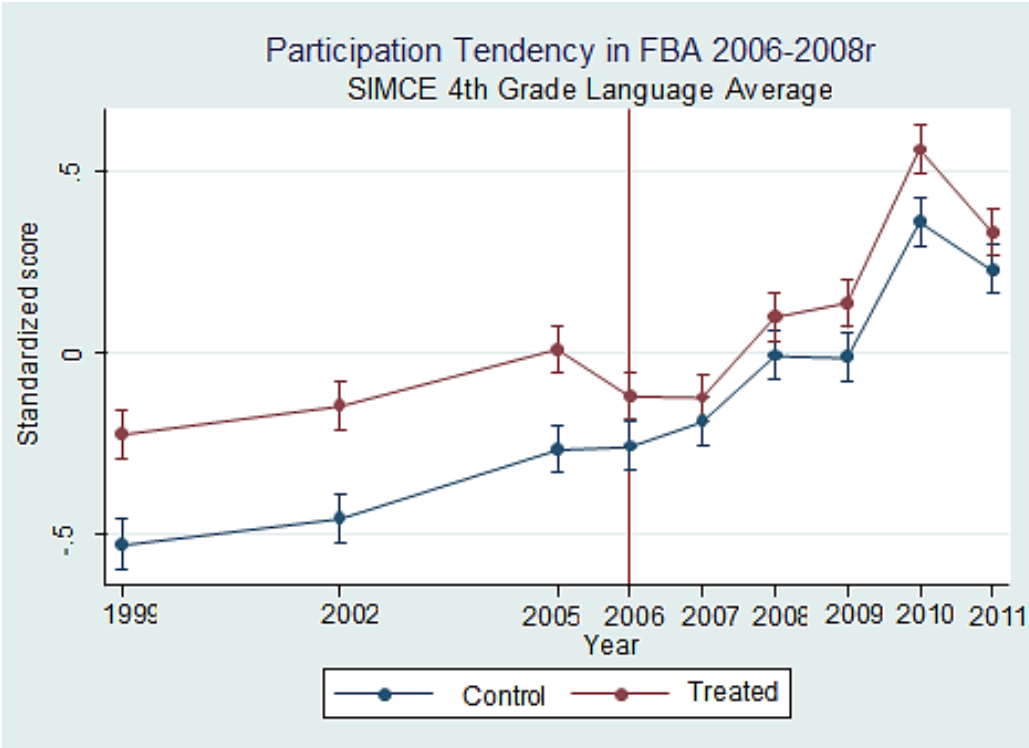
A perfect hypothesis of parallel tendencies would have been possible if we had observed the performance of the respective cohorts in the years prior to the application of the program. However, this information was not available so therefore only two types of tests were done. First it was analyzed whether or not the SEI presented significant differences in the base line tendency (that is 4<sup>th</sup> grade). Tables 16 and 17 show that the tendencies of the base line are parallel between the treated group and the control group, even when dividing the sample in accordance to the regulatory changes experimented by the programs.

**Table 16. Base line parallel tendencies test for Funds for Broadband Program in SIMCE 4<sup>th</sup> Grade**

Sample	Participation in 2006-2008r		Participation in 2009-2010r	
	Language	Mathematics	Language	Mathematics
<b>FBA X Year2002</b>	<b>0.096</b> <b>(0.07)</b>	<b>0.118</b> <b>(0.07)</b>	<b>0.116</b> <b>(0.08)</b>	<b>0.061</b> <b>(0.07)</b>
<b>FBA X Year2005</b>	<b>0.032</b> <b>(0.07)</b>	<b>0.049</b> <b>(0.07)</b>	<b>0.031</b> <b>(0.08)</b>	<b>-0.056</b> <b>(0.07)</b>
<b>FBA X Year2006</b>	<b>-0.008</b> <b>(0.07)</b>	<b>0.006</b> <b>(0.07)</b>	<b>0.098</b> <b>(0.08)</b>	<b>-0.001</b> <b>(0.07)</b>
FBA	0.051 (0.05)	0.039 (0.05)	-0.257*** (0.06)	-0.195*** (0.05)
Year2002	0.01 (0.05)	-0.174*** (0.05)	0.018 (0.05)	-0.161*** (0.05)
Year2005	0.265*** (0.05)	-0,061 (0.05)	0.292*** (0.05)	-0.029 (0.05)
Year2006	0.164** (0.05)	-0,055 (0.05)	0.182*** (0.05)	-0.034 (0.05)
Constant	-0.203*** (0.04)	0.189*** (0.04)	-0.101** (0.03)	0.310*** (0.03)
R2-adj	0.013	0.003	0.024	0.013
Value-p>F	0.00	0.00	0.00	0.00
Observations	6293	6292	5226	5226

The unit of observation is the EI. Standard errors in brackets. \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

The above tendencies test for the participation during the period 2006-2008r are observed graphically in the following illustrations.

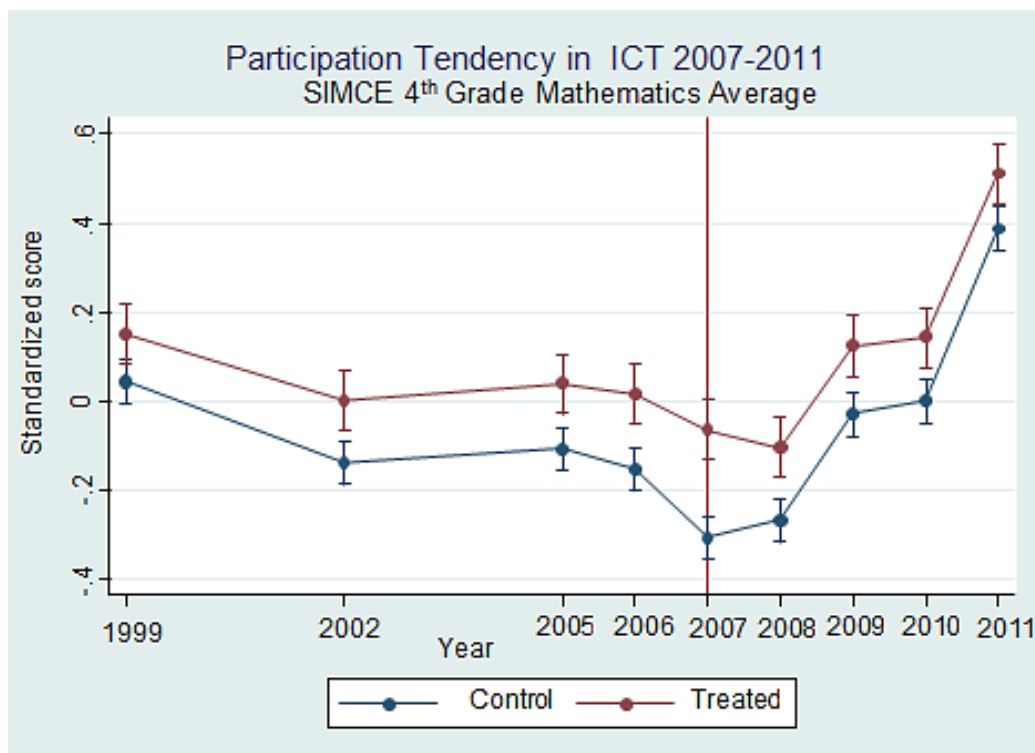
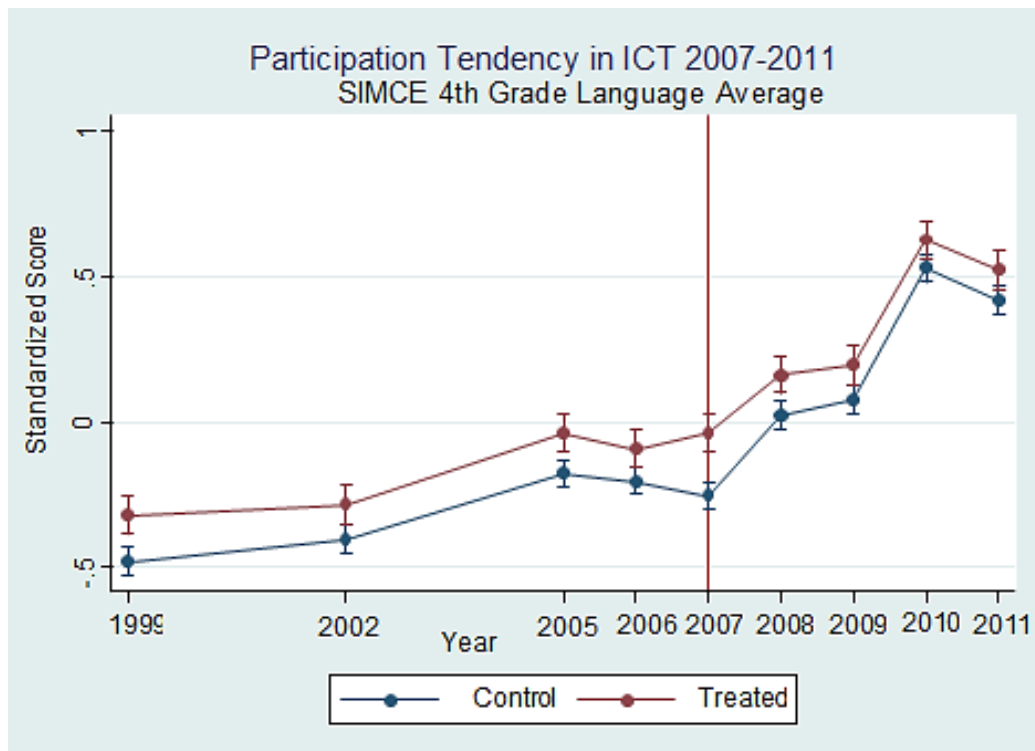


**Table 17. Base line parallel tendencies test for ICT in the Classroom Program in SIMCE 4<sup>th</sup> grade**

Sample	Participation in 2007-2009r		Participation in 2007-2011	
	Language	Mathematics	Language	Mathematics
<b>ICT X Year 2002</b>	<b>0.057</b> <b>(0.06)</b>	<b>0.068</b> <b>(0.06)</b>	<b>-0.036</b> <b>(0.05)</b>	<b>0.003</b> <b>(0.05)</b>
<b>ICT X Year 2005</b>	<b>0.023</b> <b>(0.06)</b>	<b>0.054</b> <b>(0.06)</b>	<b>-0.012</b> <b>(0.05)</b>	<b>0.007</b> <b>(0.05)</b>
<b>ICT X Year 2006</b>	<b>0.091</b> <b>(0.06)</b>	<b>0.104</b> <b>(0.06)</b>	<b>-0.006</b> <b>(0.05)</b>	<b>0.045</b> <b>(0.05)</b>
<b>ICT X Year 2007</b>	<b>0.175**</b> <b>(0.07)</b>	<b>0.176**</b> <b>(0.07)</b>	<b>0.063</b> <b>(0.05)</b>	<b>0.075</b> <b>(0.05)</b>
ICT	0.160*** (0.04)	0.132** (0.04)	0.124*** (0.04)	0.096** (0.04)
Year2002	0.041 (0.03)	-0.137*** (0.03)	0.041 (0.03)	-0.137*** (0.03)
Year2005	0.220*** (0.03)	-0.166*** (0.03)	0.219*** (0.03)	-0.166*** (0.03)
Year2006	0.118*** (0.03)	-0.212*** (0.03)	0.118*** (0.03)	-0.212*** (0.03)
Year2007	0.091** (0.03)	-0.374*** (0.03)	0.091** (0.03)	-0.374*** (0.03)
Constant	-0.306*** -0.020	0.188*** -0.020	-0.307*** -0.020	0.180*** -0.020
R2-adj	0.019	0.023	0.011	0.018
Value-p>F	0.000	0.000	0.000	0.000
Observations	10167	10166	11933	11931

The unit of observation is the EI. Standard errors in brackets. \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

The above tendencies test for the participation during the period 2006-2008r are observed graphically in the following illustrations.



However, even when the base lines are parallel, there can be systematic differences between groups in the evolution of the scores of a cohort between 4<sup>th</sup> and 8<sup>th</sup> grade. To analyze this possibility a proxy of a non-treated cohort was studied, that was in 4<sup>th</sup> grade in 1999 and in 8<sup>th</sup> grade in 2003. Since this last piece of information was not available, 8<sup>th</sup> grade for the year 2004 was used as a proxy. Tables 18 and 19 show the results for



the Funds for Broadband and ICT in the Classroom programs, respectively. It can be observed that the participation in a program does not translate into significant differences in the evolution of the SIMCE score of the cohort with respect to the control group.

**Table 18. Parallel tendencies test for Funds for Broadband Program in fictitious Cohort: SIMCE 4<sup>th</sup> Grade 1999 and 8th Grade 2004**

Variable	Participation in 2006-2008r		Participation in 2009-2010r	
	Language	Mathematics	Language	Mathematics
<b>FBA X Year2004</b>	<b>0.043</b> <b>(0.07)</b>	<b>0.040</b> <b>(0.07)</b>	<b>0.092</b> <b>(0.08)</b>	<b>0.106</b> <b>(0.08)</b>
FBA	0.052 (0.05)	0.045 (0.05)	-0.266*** (0.06)	-0.224*** (0.06)
Year2004	0.013 (0.06)	0.039 (0.06)	0.028 (0.05)	0.058 (0.05)
Constant	0.142*** (0.04)	0.120** (0.04)	0.338*** (0.04)	0.286*** (0.04)
R2-adj	0.001	0.001	0.012	0.009
Value-p>F	0.000	0.000	0.000	0.000
Observations	2913	2910	2448	2447

The unit of observation is the EI. Standard errors in brackets. \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

**Table 19. Parallel tendencies test for ICT in the Classroom Program in fictitious Cohort: SIMCE 4<sup>th</sup> Grade 1999 and 8th grade 2004.**

Variable	Participation in 2007-2009r		Participation in 2007-2011	
	Language	Mathematics	Language	Mathematics
<b>ICT X Year2004</b>	<b>0.011</b> <b>(0.07)</b>	<b>0.014</b> <b>(0.07)</b>	<b>-0.013</b> <b>(0.06)</b>	<b>0.015</b> <b>(0.06)</b>
ICT	0.186*** (0.05)	0.163** (0.05)	0.145*** (0.04)	0.119** (0.04)
Year2004	0.010 (0.04)	0.038 (0.03)	0.010 (0.04)	0.038 (0.04)
Constant	0.113*** (0.03)	0.070** (0.02)	0.096*** (0.03)	0.058* (0.03)
R2-adj	0.007	0.006	0.004	0.004
Value-p>F	0.00	0.00	0.00	0.00
Observations	3890	3889	4581	4580

The unit of observation is the EI. Standard errors in brackets. \* p<0.05, \*\* p<0.01, \*\*\* p<0.001.

Based on the overall evidence of Tables 16 to 19 it may be asserted that it was not possible to identify non-parallel tendencies in the variables of interest between the study groups, and therefore the results of an approximation of difference in differences can be interpreted as the net effect of the corresponding program.